DECEMBER 1955

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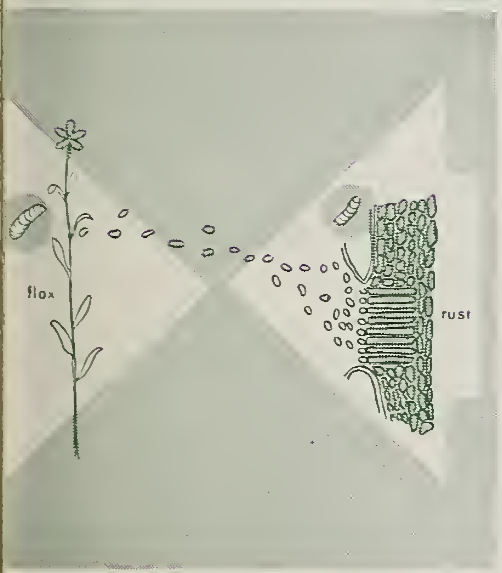
AGRICULTURAL Research

Seeking: irrigation fact
● see page 6



Meeting: rust, flax
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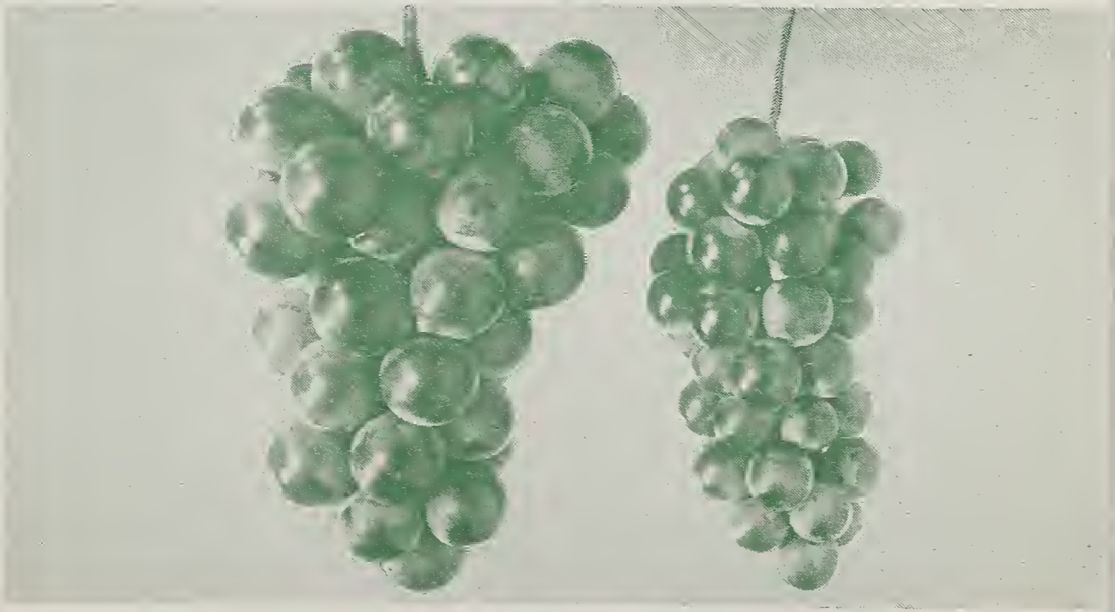

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UNITED STATES DEPARTMENT OF AGRICULTURE

AGRICULTURAL
Research

Vol. 4—December 1955—No. 6

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Dams for disease

Too often in the past, our approach to animal disease has been like our reaction to a flood threat. The tide of infection comes rolling down upon us, and we apply measures that amount to evacuating the lowlands and moving into the hills. We are rapidly reaching the point—and in some cases have passed it—where we need to do more of the basic research that will dam up the headwaters and prevent the floods.

ARS scientists and cooperators in many States are busy. They are making gains, and their findings are put to use as rapidly as possible. The recently adopted interpretation of blood tests for brucellosis is an example.

Our common animal diseases are being given all the research attention possible with the facilities and manpower available. But some projects, such as the continuing work on mastitis, take time to get significant results.

We are working on leptospirosis, atrophic rhinitis, anaplasmosis, air sac, lymphomatosis, and many others.

Sometimes newer diseases tend to crowd out consideration of older, more established ailments. A start has been made on mucosal complex, now found in 20 States (November, p. 12).

We are studying foreign diseases, because they're harder to keep out of the country than ever before with cattle, poultry, and horses moving by air transport nowadays. New research on foot-and-mouth disease at the Plum Island laboratory already shows promising results (see page 10).

Yes, we're making gains. But in the future—both immediate and long range—we must do *more* if we are to meet the constantly arising problems. More manpower, more facilities are seriously needed on many aspects of animal disease.

Our disease losses average about 1.8 billion dollars a year. Add the losses from internal parasites and insects, and the total runs more than 2.7 billion annually. That's a sixth of the farm value of all our livestock and poultry.

With our expanding need for meat and animal products, with farmers' need to raise livestock more efficiently, we must build those solid dams of basic research that will permanently help to hold back the floods of animal disease.

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AGRICULTURAL RESEARCH SERVIC
United States Department of Agricultur

Worker harvests flax in test plot at Fargo, N. D.

crops and soils

WHEN FLAX MEETS RUST

Each attacking rust gene faces a flax gene in a test of power. This same principle may also apply in other parasite-plant relationships

IT'S gene against gene when rust attacks flax—the genetic virulence of a rust race versus the genetic resistance of a flax variety.

This concept of the parasite and host relationship in flax rust may well apply to other combinations of crops and parasites—may, in fact, fit in with nature's grand plan for dealing with plant diseases in general.

This observation from USDA research may have tremendous implications in the entire field of breeding crop varieties resistant to diseases, and especially the rusts. Some of our most costly diseases are caused by fungi. None of our major crops is free of them. Breeding disease-resistant crops is the best way of controlling some of these diseases.

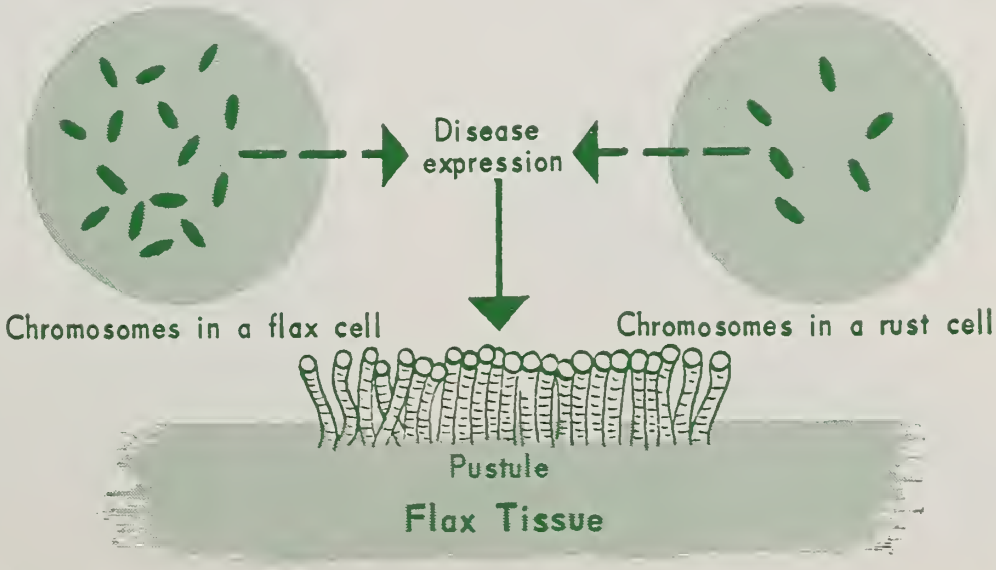
Both parasite (the rust fungus) and host (the flax) are plants. Both have genes in their germ plasm that determine the plant's characters and transmit these characters from one generation to the next. Rust breeds and produces offspring of a new genetic makeup, just as flax does. Certain genes in the rust determine how well it can grow on its host plant. Certain genes in the flax determine whether it will be hospitable or inhospitable to the parasite.

ARS plant breeder H. H. Flor, at Fargo, N. Dak., has found that for every rust gene affecting the parasite's attacking power, there's a flax gene that determines how the host plant will meet the threat. The outcome may depend on which of several contrasting genes occur in the rust and in the flax in a given situation.

Flax's susceptibility and resistance are controlled by numerous pairs of flax genes—25 that have been identified and others not yet isolated and identified. The flax rust (*Melampsora lini*) has at least 25 genes affecting its attacking power.

To find out what genes are working together in this parasite-host relationship, one must look to the effect that the one organism has on the other. The type of pustule developed is the criterion of *both* the variety's reaction to the race and the race's striking power against the variety. That fact aids in identification. Races of rust—that is, combinations of genes for striking power—are identified by the reaction of a series of flax varieties of known genetic makeup, called "rust differentials." Flax genes that determine how the plant will react to rust attack can be identified by a series of tests using known races of rust on the flax. Thus, study of rust reactions involves the genetic systems in both

1. Why a rust pustule reflects its origin



WHEN RUST ATTACKS flax, the two interact on one another to produce a pustule. In a sense, the two team together—one motivating, the other restraining—to create the effect. The pustule expresses intensity of these forces, and reflects the character of both agents.

the flax host and the rust parasite.

Genes in any plant cell are bound together in groups called chromosomes. These genes collectively determine a plant's character (subject to environmental influences). The flax genes that condition the plant's reaction to rust lie in five positions in the chromosomes. Flor calls these positions K, L, M, N, and P. For each gene at a given position, there are genes at the same position in the corresponding chromosome of other varieties of flax that have a different effect on the parasite-host relationship. The gene at the L position in one variety can command non-resistance, whereas the gene in the L position in others may call for moderate resistance, high resistance, or immunity. Of course, these various L genes can't be put together in any one plant; there's room for only one gene at the position in a given chromosome.

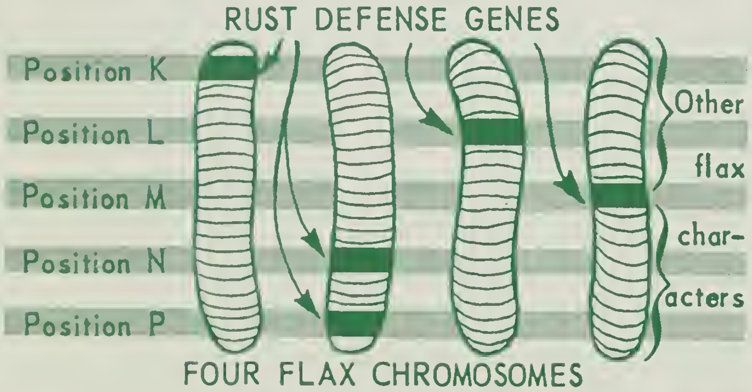
On the other hand, the 25 genes for virulence in rust occur at 25 different positions on the rust chromosomes. Although there's no single race of rust known that has all 25 genes for virulence, there's no reason to believe that all rust genes for virulence can't be concentrated within the chromosomes of a single race of rust.

The important thing to understand is that so long as a rust lacks one factor for virulence, we can breed a flax variety that resists it. The rust must advance simultaneously on all five of the plant's strongholds—if it meets a roadblock in any one sector, its campaign will fail.

Flor has developed a new series of 25 test varieties of flax, each of which has a single gene for resistance. Testing any new rust on all of them shows which genes for virulence the rust has and, more to the point, which genes for virulence it lacks. With this information, plant breeders can develop a flax that is resistant to this new race.

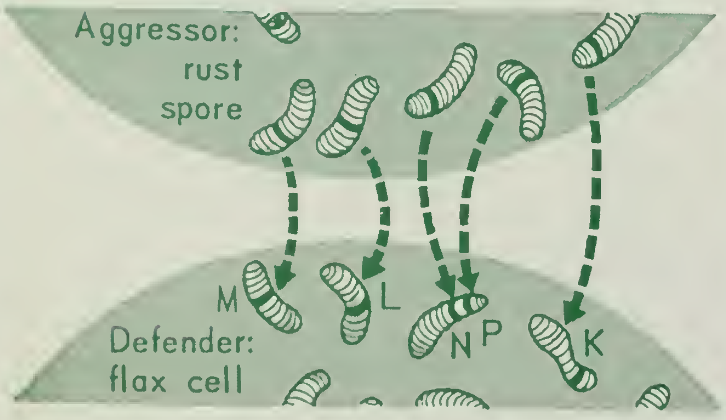
This theory of complementary action of genes in the plant-pathogen conflict—each gene for virulence in the pathogen contesting directly with a corresponding defensive gene in the host—goes to the very root of our problem in plant disease control.☆

2. Where flax's defense genes occur



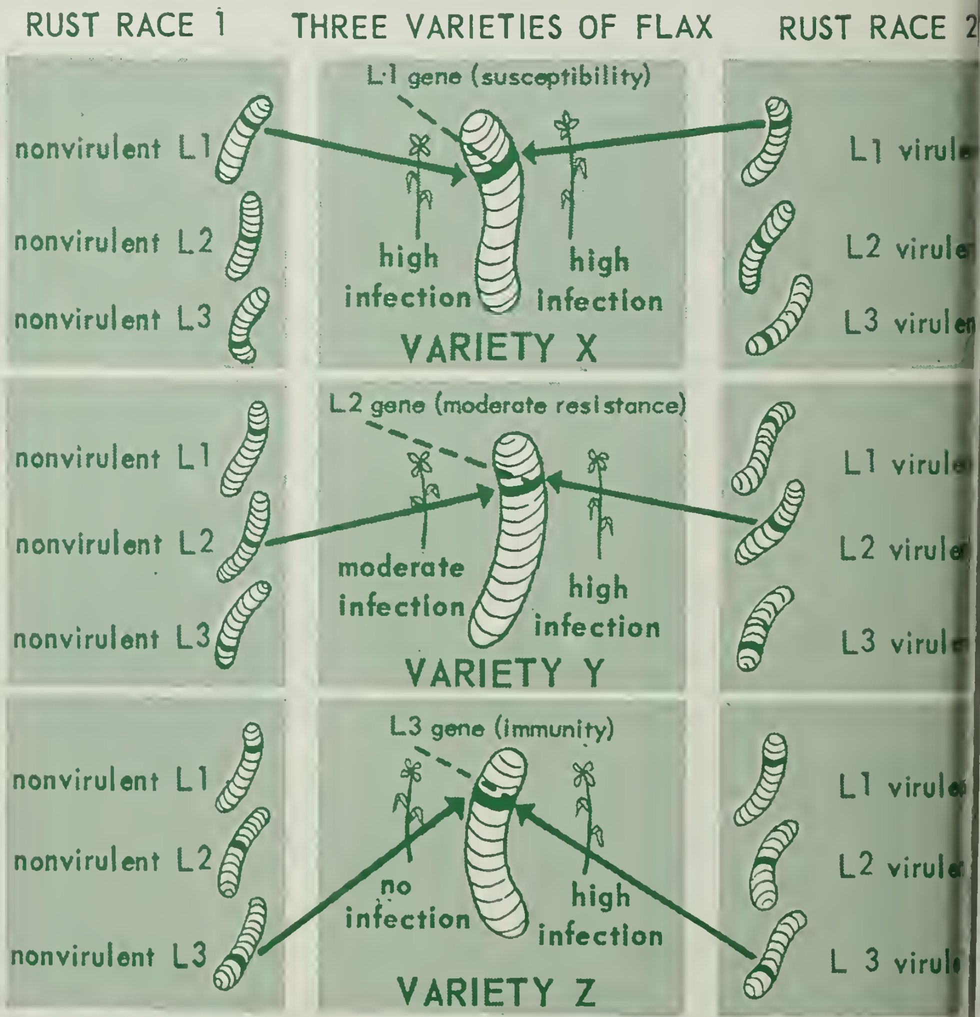
GENES THAT CONDITION a flax plant's defense against rust are located in 5 definite positions within 4 of the 15 pairs of chromosomes that occur in a flax cell.

3. Which rust genes get into action



COMBAT SPECIALIZATION pits a flax defense gene against 1 of 25 or more attacking genes. Which 5 specific genes the flax has determines which rust genes attack, for only those attack which face opposition in the flax.

4. What happens when gene meets gene



IN THESE ASSUMED CASES—six of several possibilities—rust Race 1 has three potentials for conflicts (arrows) at L, one per variety. Race 2 has three different potentials. If flax fails at K, M, N, and P, all depends on alinement at L position. (Gene symbols aren't customary genetic terminology.)

NEW THREAT BY OLD ENEMY

■ ENTOMOLOGISTS AND PLANT BREEDERS have teamed a couple of control methods—late fall planting and resistant wheats—to hold the hessian fly in check. Presently, damage to small grains (mostly winter wheat) by this insect averages about $16 million a year. Once, in 1915 (before controls), hessian flies cost more than $100 million.

Researchers keep trying to push this cost down, but they now face a possibility that these flies can overcome the resistance in grains.

It's doubtful that hessian flies will ever be able to overcome the handicap of late planting. This is a fairly old control, evolved through the years as a way of interfering with the fly's life cycle. *As long as growers heed late planting dates*, flies are no problem. But a single early seeding or a volunteer small-grain crop in a community can provide enough flies for a serious outbreak the following spring.

Small grains resistant to fly attack have provided the newer control approach—one not dependent on community action. Researchers found that incorporation of certain genes in a variety reduces infestation.

More and more evidence indicates, however, that hessian flies may be able to overcome built-in resistance. Kansas entomologists found years ago that flies from one area of the State could infest a wheat variety that was resistant to flies from another area. Wheats resistant to California hessian flies were an easy mark for Indiana flies.

Now, at Purdue University, cooperating USDA entomologist R. L. Gallun, is looking further into this phenomen. From a local hessian-fly population he has been able to develop three races, each capable of infesting wheats containing different resistant gene structures.

Gallun's Race-A hessian flies (inbred for 14 generations) readily infest 3 susceptible wheat varieties but are turned back by the 2 resistant varieties used in the experiment. Race-B flies (inbred for 6 generations) can infest the same susceptible wheats and also one of the resistant varieties. Race-C flies (also inbred for 6 generations) can infest both the susceptible and the resistant varieties.

Hybrid flies resulting from crosses among Race A, B, and C varied in their ability to infest these susceptible and resistant wheats.

Since flies with specialized reactions to resistant wheats can be bred in the laboratory, is there any reason this process can't occur through natural selection in the field? Gallun plans to find out.

He also expects to learn to what extent hessian-fly hybrids will develop on wheat varieties with particular types of resistance, the number of genes controlling the ability of each race of flies to infest all resistant wheats, and the composition of various regional hessian-fly populations in terms of their abilities to overcome resistance.☆

Northern soybean is sixteenth variety from joint work

■ THE NEW SOYBEAN variety Grant, specially adapted for conditions in Minnesota and South Dakota, is sixteenth in the series of soybeans that Federal-State cooperative research has developed for specific producing areas of the United States.

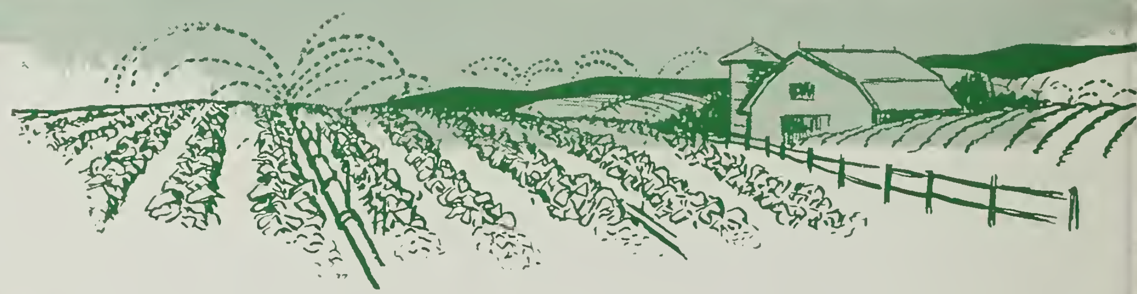
This new variety matures at the same time as Mandarin (Ottawa), 3 days earlier than Chippewa, and 4 days later than Norchief. Grant yields better than these varieties—34.9 bushels per acre compared to 32.2 for Mandarin, 33.6 for Chippewa, and 30.4 for Norchief. The oil content—20.2 percent—equals that of Chippewa and Norchief and is greater than that of Mandarin.

Experiment stations in Minnesota, South Dakota, North Dakota, Wisconsin, Ohio, Michigan, Oregon, and Canada's Province of Ontario have included Grant in cooperative uniform soybean tests since 1949. It's a selection from a cross between Lincoln and Seneca varieties.

Soybeans are one of the plants whose blossoming and fruiting are regulated by length of day and night. USDA and cooperating State experiment stations have developed varieties that mature with different night lengths to fit different latitudes. Each group is adapted to a cross-country belt about 100 miles wide.

This new variety is expected to help meet the need for adapted varieties for expanding soybean production in Northern States. The Minnesota and South Dakota experiment stations will release Grant seed to certified seed growers next spring. The increase in seed stocks thus obtained is expected to make adequate supplies available to farmers for planting in Minnesota and South Dakota in 1957.☆

Seeking Irrigation Answers



IS IRRIGATION NEEDED? HOW'S THE SUPPLY OF WATER? WHEN SHOULD IT BE TURNED ON? STUDIES OF WEATHER, SOIL, AND CROPS MAY YIELD THE FACTS FARMERS NEED

A TOBACCO grower squints at the cloudless sky, checks off another day on his calendar, and thinks: It has been 10 days since we had that soaker. According to my bookkeeping, it's time to start irrigating.

That's about the way some scientists envision that irrigation could work—when all the facts are in.

At the North Carolina experiment station, at Raleigh, State and USDA scientists are working on the basis that there's more to answering the question "Should I irrigate?" than merely measuring rainfall. Their studies show, for example, that one section of North Carolina gets an ample-appearing average of 46 inches per year. Yet, farmers in this area must expect—in about 1 year out of 5—at least 40 to 50 days of drought during the growing season.

C. H. M. van Bavel, joint ARS and State soil scientist who heads the study, says "drought" should mean there's no more available moisture in the root zone. Thus defined. drought involves not only rainfall but also the soil's water-holding capacity. the depth of rooting. and the rate of evaporation of soil moisture.

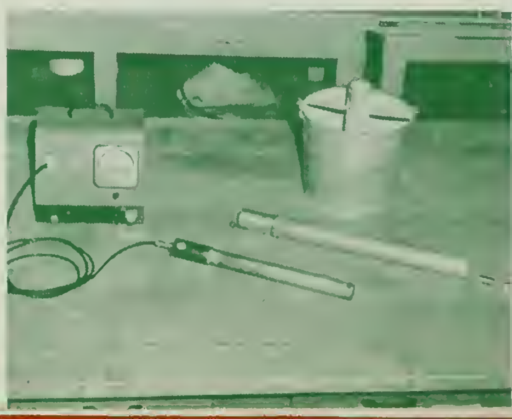
In a particular case, this way of looking at the problem could work as follows: A farmer finds out from measurements made by technicians on his soil or on similar soil from another location that his soil can hold only 2 inches of available water in the

1. Radiometer measures radiation, or heat energy, from sun and subtracts radiation from ground. Net radiation is a major factor in evaporation of moisture from plants and soil. Radiation also heats air and soil.

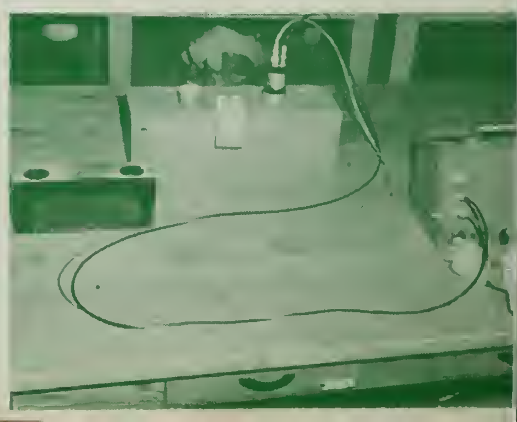
2. Strip chart recorder shows net radiation. Most days, solar minus ground radiation is a plus value; on clear nights, negative. Temperature, humidity, wind speed must be figured into final evaporation calculation.

3. Evapo-transpirometer shows the actual evaporation of water from soil. Buried barrel is filled with soil—except air space at bottom. After water percolates through, loss of percolate from bottom is measured.

4. Neutron counter (see text) measures soil moisture. Parts: meter that gives moisture in percent by volume; counter for rebounding slow neutrons; carrier for counter and beryllium-radium fast-neutron cartridges.



5. Newer soil moisture and density instrument: In tagged tube in box of soil is neutron and gamma-ray source; in other tube is phosphor—sensitive to these particles. Light flashes convert to measurable energy.



zone where his crop has its roots. Similarly, he learns that for the time of year he's dealing with, evaporation occurs at an average of 0.2 inch of water a day. He would then know that on the tenth dry day after a soil-filling rain, all available moisture would be gone. Or, if he'd had a 0.6 inch rain during the 10-day period, irrigation could be satisfactorily postponed for about 3 more days.

But this idea of estimating soil moisture conditions goes much farther. It can be used to help find out whether irrigation is needed and if available ponds or wells can supply water needs. By estimating soil moisture conditions over a large number of years, one can calculate the chances for summer drought as well as how much water is needed and how often. This information is useful not only to farmers but also, for instance, to a banker who wants to know if a loan to a farmer for irrigation equipment would be a good risk.

The benefits of irrigation must also be studied, of course, in irrigation experiments. But it would take 20 years of extensive irrigation studies, Van Bavel says, to get the needed information under sufficiently varied rainfall conditions. He hopes the cooperative research underway in the humid region, supplemented by irrigation experiments, can furnish most of the answers in a few years. Drought-probability studies have been completed for North Carolina and are being initiated in cooperation with other States. It's hoped that this work can be extended to all of the interested States as facilities permit.

In this part of the study, evaporation has been calculated from 25 years of Weather Bureau records of sunshine duration, relative humidity, temperature, and wind speed. Rainfall records for 71 locations in North Carolina have been related to these evaporation rates and to water-holding capacities of the State's soils to obtain drought-probability maps.

The estimates of drought probability are checked by careful measurements of evaporation from various crops as related to certain weather factors. Currently, Van Bavel and D. G. Harris, research instructor at the North Carolina Station, are measuring evaporation of moisture from alfalfa—a typical vegetative cover—to compare the calculated evaporation with measured values. This study will tell them much about correct scheduling of irrigations for alfalfa, and also about the fluctuations in rate of moisture evaporation from soils that are under vegetative cover.

From earlier studies with tobacco, these researchers found the evaporation rate slower than predicted when plants were small, and again when the soil water content dropped to near the point where plants wilt. Otherwise, evaporation rates corresponded closely to theoretical values calculated previously from weather data.

Extremely important has been the rapid progress in developing an accurate, practical way to measure soil moisture content and soil moisture depletion. Van Bavel believes their "neutron meter" may be the answer.

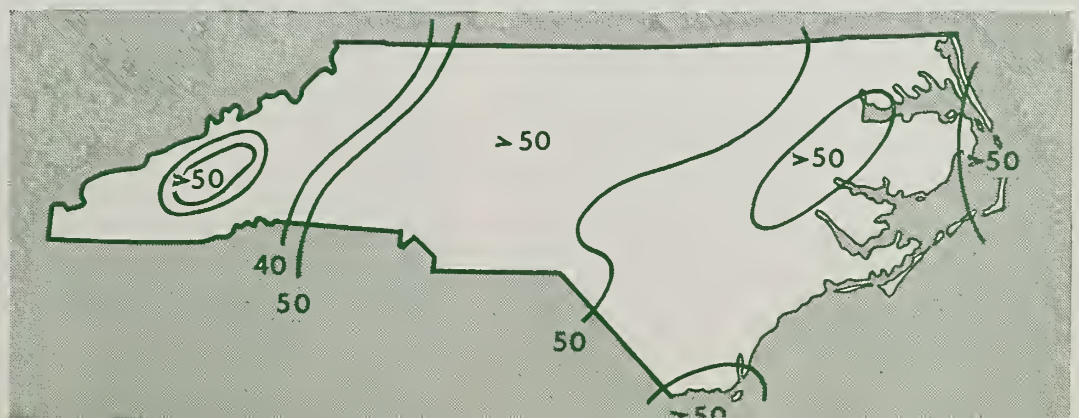
This device contains a "fast" neutron source — beryllium mixed with radium. Underground, the fast neutrons penetrate everything but hydrogen—a component of soil water. Thus, fast neutrons bounce off hydrogen nuclei to become "slow" neutrons, which are electrically counted and translated into a direct reading of soil moisture. Evaporation can be determined simply by making periodic readings.

This neutron counter is portable (13 pounds) and provides, in 2 minutes, a soil-moisture reading that requires no computation or correction. But it's rather expensive at present and is limited to averaging the moisture content of a soil layer approximately 1 foot thick.

A new, experimental, two-piece portable counter is expected to furnish soil-moisture measurements at specific depths, *plus* providing information about soil density. One unit emits gamma rays and neutrons; the other, located at the same level but at a different site, measures the penetration of energy. Soil moisture content is measured in terms of the number of fast neutrons to reach the counter; density is inversely proportional to gamma-ray penetration.☆

6. **Pressure-membrane cells indicate water-holding ability of soils. Moistened soil sample rests on sheet of plastic membrane. Cell is closed. Amount of water forced out is determined by the air pressure applied.**

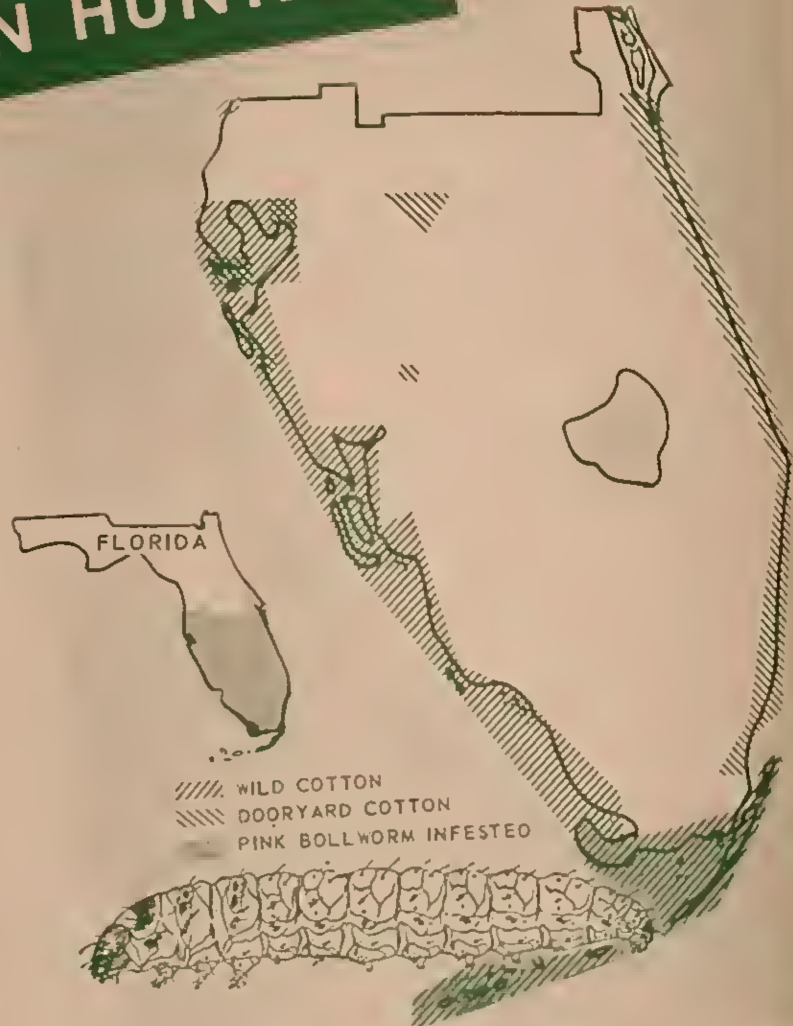
7. **Drought-probability map tells grower they can expect at least 40 to 50 days of drought (over 50 for some areas) through the April—September growing season in 1 year out of 5. Cooperating ARS and North Carolina Scientists worked out this map for soils that contain, at field capacity, 2 inches of moisture in the plant root zone. Maps have been made for all this State's soils by statistical analysis of 25 years of records from 71 weather stations.**



WILD-COTTON HUNTERS

Workers must go into the wilds to kill wild cotton—a worthless plant that harbors costly pink bollworms

1. Once abundant along highways, wild cotton is now hunted in remote places. Since the pink bollworm was found in Florida's wild cotton in 1932, eradication work has gone doggedly on as resources allowed.



ALONG south Florida's coasts and on the numberless islands that rim the State to the south and west, USDA and the Florida State Plant Board are waging a 23-year-old war of extermination against cotton plants—wild cotton and dooryard plantings. Wild-cotton bolls are midgets compared to cultivated bolls, and the plant has no economic value. But the pink bollworm, world's worst insect threat to cotton, breeds as well in wild and ornamental cotton plants as it does in field cotton.

Late each fall, wild-cotton eradication workers of the ARS Plant Pest Control Branch, working in south Florida, scrape the barnacles off their two houseboats and prepare to hunt and destroy all the wild-cotton plants they can find. Other workers live during the season in a windswept camp at Cape Sable, on the southern tip of Florida. A third large crew is recruited at Homestead and is transported by truck to destroy wild cotton in the Florida Keys. Still other workers range isolated areas from the Everglades to St. Petersburg, using trucks and small boats for their task. Because of mosquitoes and other insects, and standing water in the low-lying country during the rainy season, cotton eradication can be carried on only during the dry season of winter and very early spring.

Wild cotton is found on some 17,000 acres in more than 900 separate colonies distributed over many hundreds of square miles. Many of these colonies are remote and almost inaccessible. No one knows how Florida's wild cotton originated. It may be native to the area, or seeds may have washed in with the tides, or it may be descended from cotton planted during the Civil War.

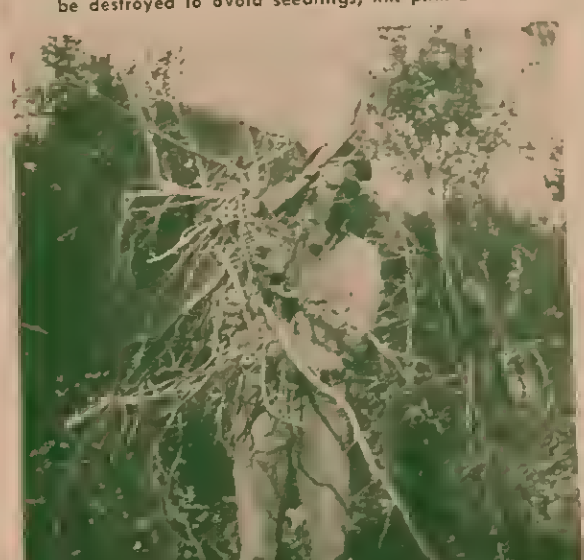
Wild cotton can grow into tall, thick shrubs. Most of these plants are pulled out by the roots. But as the easily-spotted specimens are destroyed, locating young seedlings in the lush, sub-tropical Florida jungles becomes a needle-in-haystack operation. Seeds spread by high tides, storms, birds, animals, and sometimes by wind can germinate during all seasons—or lie 15 years or more awaiting favorable conditions for sprouting.

Unfortunately, cotton makes attractive ornamental dooryard plantings. Several thousand premises must be inspected annually, up and down Florida's east coast, to find and remove such plantings. Most homeowners give up dooryard plants with good grace when the pink-bollworm hazard is explained to them. Florida State Plant Board inspectors cooperate by removing or reporting such plants, and nurseries no longer grow cotton plants for sale.

The pink bollworm, which invaded Texas from Mexico about 35 years ago, has been confined to southwestern commercial cotton. In 1953, however, this pest spread to within about 75 miles of the Mississippi River in Arkansas and Louisiana. It did about $30 million damage to a limited area of south Texas cotton in 1952. Tight controls coupled with extremely dry weather reduced the pink bollworm's 1954 ravages to only occasional damage, but even then it destroyed cotton worth up to $300 an acre on a few irrigated farms in west Texas.

The pink bollworm is now found in the Southeast only in wild cotton (and occasionally in adjacent okra) at Florida's tip and on the Keys. No domestic cotton is grown below north-central Florida, to the north of the wild-cotton area. The pink bollworm spread to fields there in 1932, however, and was eradicated only at great cost and effort. Cotton production is now prohibited by law in much of southern Florida. This creates a barrier zone that extends some 300 miles between infested wild cotton and the Southeast's commercial cotton fields.☆

2. Wild cotton must be pulled or dug out to the last rootlet—new plant may develop from remnant left. Missed plants multiply problem. Mature bolls must be destroyed to avoid seedlings, kill pink bollworms.



3. Some roots of wild cotton are buried deep under rocks. Chemicals—hard to transport—are used to kill plants that can't be pulled out. Brush cutting is prohibited in Everglades National Park, where much of the work's done.

4. Some workers live on ch-drawn houseboats over dry winter season. So 0 wild-cotton colonies can be reached only by boat. -bollworm infestations in wild cotton of Key islands arer banks are greatly reduced.

5. Unique "runner" bridges, hand built from timber deposited on shore by hurricanes, make parts of swamps and jungles accessible by car and truck. Supplies, including drinking water, often must be hauled as far as 40 miles.

6. Workers go as far as possible by vehicle and boat but often must walk long distances. Water, dense weeds, trailing vines, prickly cacti, poisonous plants and snakes, and hordes of mosquitoes slow progress.

PROGRESS ON FOOT-AND-MOUTH

Kidney-culture way to grow virus can provide enough for research use

SUCCESS in growing the foot-and-mouth virus in cultures of swine or cattle kidney cells at the USDA Animal Disease Laboratory at Plum Island, N. Y., is opening the door to further research on this disease. A method developed by H. L. Bachrach, W. R. Hess, and J. J. Callis of the laboratory staff makes possible large-scale production of the virus for fundamental studies and vaccine investigations at low cost. Kidneys from one calf supply enough cells to prepare about 50,000 cultures in test tubes, or more than 300 large-scale cultures in quart-sized flasks.

This accomplishment enables workers to use practical tissue-culture techniques in diagnosing foot-and-mouth disease and identifying the type of virus present. Scientists can also use the method to determine the concentration of viruses and antibodies produced in animals.

In developing the method, the researchers used Type A virus, one of six recognized types causing this disease. First step is to prepare a culture consisting of a suspension of cattle or swine kidney cells in a nutrient solution containing salts, cattle blood serum, and antibiotics. Test tubes or flasks containing the culture are placed in an incubator, where the cells grow for several days. Then each culture is inoculated with virus, which immediately begins to reproduce itself in the kidney-cell medium.

Foot-and-mouth virus has been grown experimentally in other types of cultures by European investigators. The work at Plum Island, however, is the first in which hog and cattle kidney cells have been used for routine virus production in quantities needed for research purposes. The method is similar to that employed in growing human-polio virus for the manufacture of polio vaccine.

Work on foot-and-mouth disease has been under way at Plum Island only since mid-May 1955. This is the first development to be reported of research conducted inside the United States on the highly contagious disease. Before this laboratory was established off Orient Point, at the eastern end of Long Island, no research on foot-and-mouth disease had been permitted in this country.

Earlier work at the laboratory—it began research operations in July 1954—was confined largely to vesicular stomatitis, another virus disease of livestock. Symptoms of this disease are similar to those of foot-and-mouth, and research on VS was undertaken at Plum Island partly as a means of testing the laboratory's maximum security measures before studies of the more dangerous foot-and-mouth disease began.

Because of the extreme safety precautions that must be taken with foot-and-mouth disease to prevent escape of the virus, the present facilities on Plum Island can accommodate research on only one type of virus at a time. But a new laboratory now under construction on the island is expected to be operating within the next 4 or 5 months. This will provide adequate facilities for simultaneous work on several virus types. The Plum Island laboratory is administered exclusively by USDA for research on dangerous foreign animal diseases, primarily foot-and-mouth.

There has been no outbreak of this disease in the United States since 1929, but in recent years it has threatened from both Mexico and Canada. The eradication campaign in Mexico begun in 1947 cost the United States Government more than $130 million. It has been estimated that if the disease became firmly established in this country, it could reduce our production of meat and other animal products by as much as 25 percent.

Foot-and-mouth disease affects cloven-hoofed animals—cattle, sheep, goats, deer, elk, buffalo, and antelope. It can also be produced experimentally in embryonating eggs, guinea pigs, mice, chickens, and other laboratory animals. Human beings have rarely been affected, even after repeated and intensive exposure. But persons or objects that come in contact with infected animals, as well as meat, milk, or other products from such animals, can transmit the virus to noninfected livestock.☆

Can immunization control lungworm?

PRELIMINARY RESULTS SUGGEST THIS POSSIBILITY FOR CATTLE

A NEW research approach that might lead to eventual control of the cattle lungworm by immunization has been demonstrated by USDA scientists R. Rubin, T. B. Weber, and J. T. Lucker. This is particularly significant because there's no satisfactory treatment for the disease.

The ARS researchers first showed that an immunity was acquired by calves that recovered from an initial lungworm infection. The high degree of protection this immunity can afford was shown by the fact that one recovered calf was able to survive an initial *reexposure* to 750,000 infective larvae. A previously uninfected calf died 7½ days after an identical exposure. The resistance was shown to last at least 7 months but apparently diminished with time. Age resistance—rather than acquired immunity—was ruled out since previously infected calves of comparable age and a 14-month-old yearling were found to be highly susceptible.

With these encouraging results, the scientists then tried to transfer immunity to susceptible calves by injecting serum from immune animals. That is, immunity would be passively conferred by antibodies in the serum rather than actively produced by infection with the parasite.

The source of immune serum was a 14-month-old animal that had been reexposed to a total of 874,000 larvae at intervals over the preceding 12 months. Its resistance was shown by failure of these repeated reexposures to result in reinfection after recovery from the initial infection. The immune serum was prepared from blood taken 2 weeks after a last exposure of this animal to 500,000 larvae.

Six helminth-free Holstein calves, 2 months old, were infected with 50,000 lungworm larvae—normally a lethal exposure. Four of the animals simultaneously received immune serum intravenously. Each received a different dose—the maximum about 1½ pints. The fifth animal received normal serum from a lungworm-free 8-month-old calf. The sixth received the maximum dosage of immune serum when clinical symptoms became evident 8 days after infection.

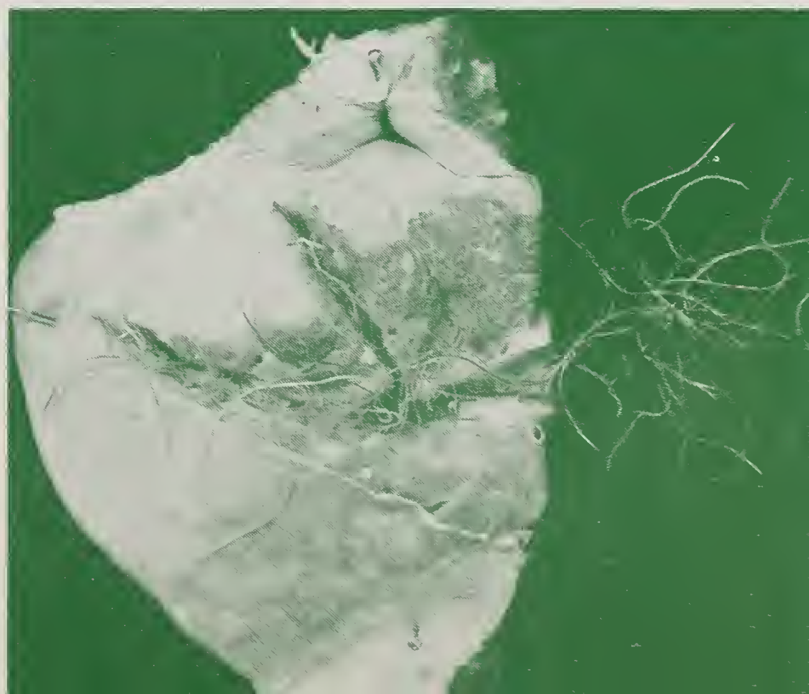
Two calves survived—the one that received the largest dose of serum when the larvae were administered and the animal that received the same dose 8 days later. Results with these two animals were not significantly different. The other four calves died of lungworm infections.

But even in these four animals the immune serum was beneficial. The worms took longer than usual to reach maturity, and the output of their progeny in the feces was lower. The number of worms recovered at post-mortem examination and the proportion of retarded worms indicated that resistance was related to the amount of immune serum given. The calf that got normal serum died before the lungworms could mature.

It was found that some of the larvae administered to an animal with an acquired resistance can reach its lungs. But usually most of the young worms are rather promptly eliminated and few if any reach maturity. The results do not show whether the resistance prevents larvae from penetrating the gut wall and reaching the circulation, or how the resistance acts to destroy them in the lymphatic or circulatory systems. Probably, the percentage of larvae reaching the lungs is much less in resistant than in susceptible animals. The promptness with which the young worms are eliminated apparently depends upon the degree of resistance.

Similar results on acquired resistance and the transfer of immunity have been reported in England.

ARS studies are now in progress on the host-parasite relationship, the method by which parasites are destroyed in an immune animal, and a technique for producing active and lasting immunity without producing symptoms. Electrophoresis, precipitation tests, and complement-fixation tests are among the tools researchers are employing in this work.☆



MATURE LUNGWORMS, 2 to 3 inches long, occurred in a pig's bronchial tubes. Numerous eggs produced by female worms usually hatch in air passages, liberating larvae that are coughed up, swallowed, and eliminated in the feces. Symptoms are frequent coughing spells, difficult breathing, progressive weakness. Death is result of exhaustion or suffocation from blocking of air passages by worms, along with mucus and pus.

fruits and vegetables

BIG GRAPES COMING

Polyploidy yields three commercial grapes plus others for breeding

THREE man-made tetraploid strains of grapes from USDA research—1 new eastern grape and 2 southern muscadines—show commercial promise for the South.

These are larger-berried forms of an old variety and two experimental selections. They seem to have the fine qualities of the grapes from which they were created.

ARS cytologist Haig Dermen created these and 27 other tetraploids at the Plant Industry Station, Beltsville, Md. Working with young vines of 10 eastern bunch grapes (*labruska* type), 4 California grapes (*vinifera*), and 16

BIG GRAPES on this Loretto vine resulted from the artificial doubling of its chromosome number. Size contrasts sharply with the typical small fruits (lower branch) on standard Loretto wood. With bigger size, this high-quality variety has commercial possibilities.

muscadines, Dermen treated vegetative buds with the drug colchicine (AGR. RES., Oct. 1953, p. 3). He got chromosome doubling in at least one shoot of each variety or selection. Normal bunch grapes have 38 chromosomes, the muscadines 40. The tetraploids have 76 and 80, respectively, and the greater fruit size you'd expect.

The tetraploid Loretto bunch grape first bore a full crop in 1955. It had some berries 3 times as large and bunches 2½ times as large as the normal diploid Loretto. That's comparing the largest berry and largest bunch of each. Seeds, large for the small-fruited Loretto, are a little larger in the big ones. In the muscadines, berries were almost doubled in size in the tetraploids.

Aside from its good quality and the many bunches borne per vine, ordinary Loretto's big asset is its ability to survive in the Deep South, where most bunch-grape varieties succumb to disease in 2 or 3 years. Tetraploid Loretto may prove to have real value in the Southeast.

Muscadines are the most satisfactory grapes for the South. Along with desirable flavors, they have high resistance to most grape diseases, a southern problem.

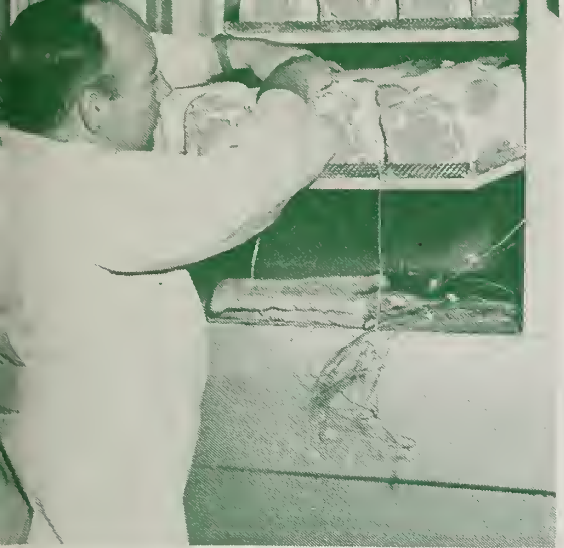
Scientists are trying to capitalize on this disease freedom through three lines of work. The first phase deals with the problem of needing separate vines for pollen and fruit—10 percent of a planting must now be nonbearing vines for pollination. Thus, perfect-flowered vines could raise production 10 percent. C. F. Williams, working jointly for ARS and the North Carolina experiment station, and N. H. Loomis, of ARS, have bred a perfect-flowering character into 70 or 80 experimental lines.

Dermen's chromosome doubling in some of these perfect-flowered muscadine grapes is the second phase.

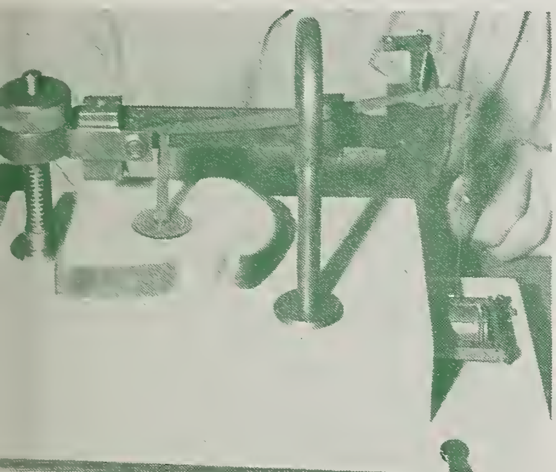
The third phase is to cross our better muscadines—perfect-flowered ones—with desirable eastern and California bunch grapes to get disease-free bunch grapes for the various regions. Williams and Loomis have tried this with diploids but got sterile hybrids. Crosses of the tetraploids however, may give some fertile hybrids.

Some of Dermen's tetraploids in addition to the three mentioned above are still on young vines—may yet show big fruit when vines mature. The most promising tetraploids are being propagated as rapidly as possible for extensive testing to see where they're adapted, and how well. No plants will be available commercially until these tests are completed—a matter of several years.

Choice of varieties for doubling was based on characters needed in breeding—especially disease resistance and, in some cases, fruit size. By removing the obstacle of small size in some good grapes, Dermen has made them and their superior qualities available for breeding. He has gotten his results in 3 short years. Of the tetraploids nature has given us, only one is commercially important.☆



THERMOCOUPLES are inserted in loaves placed in a blast freezer. In this manner, temperatures at various locations in loaf can be recorded during the freezing process.



COMPRESSIMETER gives accurate measure of bread crumb firmness. This instrument measures slight amount of force needed to compress thick, uniformly cut bread slices.

CRUMBLINESS develops as bread stales, and this is a device to measure it. Bread cubes of uniform size are shaken in sieve a given time, then crumb loss is determined.

Bread—Freeze It, Store It

WE'RE GETTING ANSWERS ON A PRACTICE THAT'S ATTRACTING INCREASING COMMERCIAL INTEREST

COMMERCIAL freezing may give us cheaper, better bread. This practice could reduce staling, loss on unsold loaves, costly night baking.

By extending the market for bread, freezing could also help reverse our long-term downward trend in wheat consumption. In 1900 the per capita consumption of flour was 225 pounds. In 1954 it was 124 pounds.

The increasing commercial interest in freezing bread has spelled out a need for technical information. Such research is well along at the Western Utilization Research Laboratory, in cooperation with the Refrigeration Research Foundation.

Findings to date show that air velocity and position of loaf in the air stream are the most important factors in freezing *unwrapped* bread. For *wrapped* bread, the temperature level itself is more important.

Bread is best when it is frozen as rapidly as possible as soon as it leaves the oven. Quick defrosting is also preferred. The freezing time affects crumb firmness more than the defrosting time does. Frozen bread should always be stored separate from strongly flavored materials.

The maximum storage temperature for top quality bread is 10° F. for short periods (about a week) and 0° F. for extended storage. Firming of the crumb continues slowly at temperatures just below freezing.

Frozen bread stored for more than a day should be wrapped in sturdy moisture-vapor-resistant material that is flexible at low temperature. The volume shrinkage during freezing increases requirements to be met by satisfactory wrapping materials.

Humidity as well as temperature affects defrosting rates. That is, excessive condensation on wraps may occur in humid air, but the defrosting rate is faster because moist air has greater heat-carrying capacity.

Thawed bread, placed on grocers' shelves or kept in the home, will not firm up faster than unfrozen bread—provided the freezing and thawing have been conducted properly.

Investigations on the distribution of moisture in unfrozen and in frozen and defrosted loaves should help explain the effects of freezing. With the exception of the crust, most of the loaf has a rather uniform moisture content immediately after baking. In the next few days, moisture moves gradually into the drier crust regions—and if the wrapping is ineffective, there is a decrease in total moisture. This migration is slow, but small changes have significant effects on palatability.

Moisture distribution in frozen bread is essentially the same as in freshly baked bread, and the distribution will remain that way for 4 to 7 weeks at 0° F. Neither freezing nor defrosting appears to cause moisture to shift around in the loaf. Likewise, defrosting by microwave energy—where the inner parts of the loaf defrost as rapidly as the outer parts—causes no significant change in moisture distribution in bread frozen when fresh from the oven.☆

New acid in rosin

NAVAL-STORES RESEARCHERS EXPLAINED SOME ROSIN MYSTERIES IN FINDING THIS NEW CHEMICAL AND OTHERS YET UNIDENTIFIED

A USEFUL new chemical—palustric acid—has been isolated from pine-gum rosin by a team of research chemists at the USDA Naval Stores Station, Olustee, Fla.

The information concerning this new acid has already proved valuable in the preparation of paper size and is the most recent payoff of research aimed at making rosin a more versatile naval-stores product.

Chemists Virginia Loeblich, Emily Baldwin, and R. V. Lawrence believe they have also discovered (but not yet identified) at least three other new rosin acids. Their successful search has been based on the partition chromatography process, which can separate the acids contained in rosin. (See illustrations below.)

New knowledge of palustric acid and its relatively unstable nature answered a question that had long disturbed naval-stores researchers: Why had it been impossible to reconstitute pine gum from rosin and turpentine? They know now that time and temperatures used in gum distillation destroy the identity of some of the less stable rosin acids. For example, a normal distillation temperature of 330° F. will cause some of the palustric acid to be transformed into less valuable abietic acid.

Presumably, as industrial demand for the new rosin acids grows, pine-gum processors will find it advantageous to save these acids by using milder methods of gum distillation.

Isolation of palustric acid is the latest of a long succession of research achievements coming from the Olustee station. During its 22-year history, scientists here have developed a

1. Acids in rosin are separated by pouring solvent into column that contains rosin adsorbed on silica gel. Various acids move down the column at different rates, are metered into tubes on the revolving turntable.

2. Each of successive rosin-acid fractions caught in tubes (100 drops per tube) is titrated against known standard to find the acid concentration. Plotting the concentrations against acid fractions provides graph.

3. Peaks on this chromatographic graph represent concentrations of different acids. Size of Peak 3—palustric acid—indicates it makes up about 15 percent of rosin. Peaks 2, 4, 5, 6 indicate new, unidentified acids.

method of continuous gum distillation that requires only about half as much steam as batch distillation. The continuous-distillation method is rapidly gaining favor.

From crude gum, the scientists have developed maleo-pimaric acid—a white powder used industrially in printers' ink, paper sizing, alkyd resins, and photographic chemicals.

As they are now doing with rosin, the researchers have in years past prepared and separated from turpentine many important chemicals. These include several of the esters of pinic acid, which are suitable for use as lubricants for engines of jet aircraft and as plasticizers (fillers for plastics). Another turpentine derivative known as pinane hydroperoxide can be used as a catalyst in the production of cold rubber.

Addition of metals such as lead and manganese to aldehyde-modified rosin resulted in improved metal resinates, valuable as paint driers.

In all, scientists of the Olustee station have acquired more than 60 public-service patents for research-developed naval-stores products and processes. These achievements have directly or indirectly benefited more than 400,000 people in the southern pine-gum producing area.☆

4. Further analysis of acid fractions by ultraviolet and infrared spectrophotometry helps identify various rosin acids by their color-absorption characteristics. Scientist is shown using infrared spectrophotometer.

ONE TAG—ONE NUMBER

■ In Nationwide dairy and beef cattle programs, it's important to have a method of identifying individual animals without duplication in any part of the country. Workers need to have the exact identity coupled with accurate records of each animal's performance in milk production to compare animals in our extensive dairy-herd-improvement and artificial-breeding investigations. In cattle-disease eradication, when it's necessary to find where an infected animal originated, cases can be traced only if the animals sent to market are adequately identified.

The present identification system often results in duplicate numbers for DHIA animals—which causes confusion when records are handled on modern recordkeeping machinery. Sometimes a slaughtered diseased animal has the same number as an animal still living. Or one animal has several numbers if it's involved in different programs.

Recently, USDA devised a uniform plan for exact animal identification throughout the country. This plan is based on a numbering system that has already been found practical for dairy-herd-improvement work. (DHIA recordkeeping was described in Agr. Res., October 1955. p. 12.)

The new system provides a combination of letters and numbers sufficient to tag more than 8 billion cattle without a single duplication. Each animal will get only one number, imprinted on an eartag. The number will be used by all the groups concerned with the animal. And there won't be the danger of several cattle having the same number.

There's another advantage too—only one eartag is needed. Farmers prefer a single tag and have long complained of the "Christmas tree" effect when several tags are attached to an animal's ear.

In the new system, each State will keep a single "book" (record of number assignments) and every number issued in that State will carry the State code number. For example, the complete series of numbers in Wisconsin, with code number 35, will run from 35–AAA0001 through 35–ZZZ9999. Other States will use similar series prefixed with their own code for the agricultural groups within their borders.

This system allows 169,000,000 different numbers for each State. Within the full block of numbers, a group might wish to use the X series, providing 6,760,000 different numbers. One section of this group might then be alloted the XA series, another the XB.

Official agencies and groups will continue to buy identification tags where they choose. But these agencies will first obtain a block assignment of numbers from the book and will be responsible for making and recording assignments of numbers to their members. The backs of the eartags may carry the name or initials of the purchasing group.

USDA anticipates that the new numbering system will be quickly and widely adopted as States establish central booking offices.☆

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agrisearch notes

RYANIA has again shown its value as a selective insecticide. Studies on apples were carried out cooperatively last season by USDA and the West Virginia experiment station.

Many powerful insecticides upset Nature's own control methods by killing natural enemies of insects. But ryania combines natural biological control with man-made chemical control.

Advantages of this botanical insecticide are (1) action on the apple's insect enemies—not friends; (2) control of the codling moth, even if DDT-resistant strains develop; (3) no harm to plant tissues, comparative safety for man and warm-blooded animals, and no problem from its residue on crops.

Ryania was used with glyodin fungicide, from the second cover spray.

TIMELY, HEAVY FERTILIZATION of Coastal Bermuda grass pastures can be profitable for southeastern farmers, a 13-year study by USDA and Georgia Coastal Plain Experiment Station shows.

Advantages of this grass are high yielding ability, disease and drought resistance, and a wide range of adaptation. But sufficient nitrogen for maximum growth is not available in the soil at most locations.

The cooperative research revealed that nitrate of soda and ammonium nitrate are equally effective (pound for pound of N), and more efficient than uramon and cyanamid when applied as top-dressing materials.

Increased yields, succulence, and protein content were obtained by splitting nitrogen applications when moisture is plentiful in the spring and early summer. Efficient use of this moisture can be important.

Coastal Bermuda fertilized in early March with 100 pounds of N and 500 pounds or 0–10–20 per acre has produced more than 2 tons of hay per acre by late May—several times more than unfertilized or May-fertilized grass. Annual yields were increased from 1 ton per acre with no nitrogen to 8 tons where 400 pounds of N are applied annually.

The 100-pound rate of N gave the *greatest yield of hay* per pound of N. The 200-pound and 400-pound rates produced *the most protein* per pound of N. Percentage of nitrogen recovered was unusually large.

Grazing studies indicate that Coastal Bermuda will produce approximately 275 pounds of beef per acre with an annual application of 36 pounds of N. The grass makes excellent silage, without use of a preservative, when fertilized as for hay and cut at the hay stage.

FIELD CURING is a poor way to preserve alfalfa for dairy cows. A 5-year USDA study shows that putting alfalfa up as silage provides a more nutritive feed and results in higher-quality milk, with more carotene and vitamin A.

Barn-drying alfalfa hay with forced air is a good supplement to silage-making.

Leaf losses for field-cured hay averaged 1.7 times greater than for barn-dried hay, 2.7 times greater than for silage, 6.7 times greater than for dehydrated hay.

The dry-matter loss from field-cured alfalfa hay was 1.5 to 1.8 times as much as for barn-dried hay (unheated and forced-air heated, respectively), 1.6 times as much as for wilted silage, and 2.8 times as much as for dehydrated hay.

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